Terahertz In-Line Sensor for Perforated Pan Film Coaters

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Purpose

Terahertz pulsed imaging (TPI) is a relatively recent non-destructive analysis technique that was successfully employed to study the coating of solid dosage forms. It utilizes very short pulses (< 1 ps) of radiation at terahertz frequencies, located between the microwave and infrared regions of the electromagnetic spectrum, which can penetrate the coating.

Until now this measurement technique was confined to high resolution imaging instruments which can be used in research and development laboratories. Here we present the first in-line sensor head that can be used to measure the coating thickness of individual tablets in a coating pan in situ. We are able to demonstrate that the sensor is able to measure in real time and at production scale.

Methods

An in-line TPI system (TeraView Ltd., Cambridge, UK) was developed and installed on a production-scale side-vented tablet coater (Premier 200, Oystar Manesty, Mersseyside, UK). The sensor was externally mounted on the perforated coating pan such that the surfaces of tablets moving inside the rotating coating pan are presented at the focus of a continuous train of terahertz pulses. The perforated drum had a diameter of 1.3 m. Each circular perforation of the drum was 3 mm in diameter with 51% of the external surface of the drum being open.

The system was tested during a 5 hour coating trial in which a polymer film (Acryl-EZE, Aquous Analytics System yellow and pink, Colorcon Ltd., Dartford, UK) was applied to a batch of tablets. The batch size was 175 kg. The tablets were bi-convex (10 mm diameter, 370 mg) and consisted of direct compressed lactose monohydrate (Meggle, Wasserburg, Germany).

Reflecting time-domain waveforms were recorded at a rate of 120 Hz (acquisition time of a single waveform 8.3 ms). No signal averaging was performed. An in-house written algorithm was used to identify suitable time-domain waveforms from the data stream which corresponded to reflections at normal angles of incidence and in focus of the terahertz optics. This analysis was performed in real-time and the coating thickness measurement was displayed continuously on the screen of the coating unit.

Results

A schematic of the pan coater fitted with the terahertz coating sensor. B) Successful terahertz measurement of the coating thickness of a tablet in the coating pan through a single hole of the drum mesh. C) Measurement of a reference reflection from the mesh. The terahertz pulse is shifted in phase and much larger in amplitude allowing an easy discrimination between the reference waveforms from the drum mesh and the coating measurements from the tablets in the coater.

Photo of the terahertz coating sensor after a 5 h coating run. Note that the polymer dust is deposited on the outside of the sensor casing. There was no polymer deposit on the optics of the sensor itself.

Photograph of the terahertz coating sensor after a 5 h coating run. Note that the polymer dust is deposited on the outside of the sensor casing. There was no polymer deposit on the optics of the sensor itself.

Conclusions

We have developed and evaluated a new in-line sensor technology for quantitative film coating thickness measurements of individual tablets during film coating in a perforated pan coater. The technology has considerable potential for PAT and QbD applications in film coating development. Alongside numerical simulations further research will investigate how this technology could be used to optimise the coating process through first principles understanding.

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